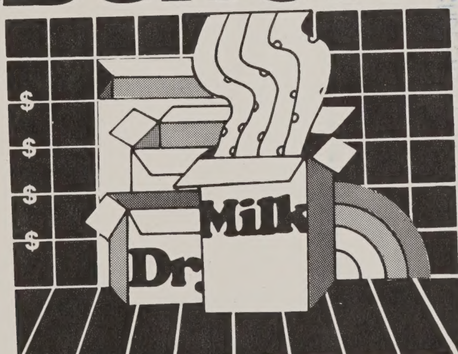
Costs of Dry Whole Milk Packaged For Household Use



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ABSTRACT

Cost estimates are for dry whole milk packaged in laminated foil pouches for household use. Total cost is analyzed on the basis of using either a single-pass or double-pass instantizing process. In the single-pass procedure, raw material costs accounted for an estimated 75.4 percent of total cost, while packaging costs amounted to 21.1 percent. For the double-pass process, raw materials were 69.9 percent of the total, and packaging was 19.5 percent.

Keywords: Milk products, Costs, Processing, Packaging, and Dry whole milk.

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SUMMARY

Processing cost for dry whole milk, packaged in laminated foil pouches for household use, would be approximately 54.75 or 59.08 cents per pound. The lower figure represents the estimated cost when using a single-pass instantizing process, while the higher figure is for the double-pass procedure. Taking into account the March 15, 1973, increase in support price for manufacturing-grade milk, the estimates would increase to 57.06 and 61.39 cents per pound.

Since dry whole milk is not currently packaged nor retailed for consumer use in flexible packages, these cost estimates are based upon material contained in published reports, information obtained through personal visits to powder processing plants, and the economic-engineering method of analysis. The estimates include the costs of raw materials, instantizing, and packaging.

Raw materials and packaging costs represent the greatest proportion of total cost. If the single-pass instantizing process is used, raw material costs account for 75.4 percent of the total cost, and packaging costs, including the cost of the gas used to flush the pouches, account for 21.1 percent. For the double-pass process, raw materials are 69.9 percent of the total, and packaging, 19.5 percent.

COSTS OF DRY WHOLE MILK PACKAGED FOR HOUSEHOLD USE

by

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INTRODUCTION

Dry whole milk, after being reconstituted, has not found general acceptance as a beverage. This lack of acceptance is probably the major reason that most domestic consumption of this product is as an ingredient in other processed foods. Also, it is undoubtedly one of the primary reasons that dry whole milk production is low compared with production of nonfat dry milk.

Production of dry whole milk totaled 68.9 million pounds in 1970 and 72.2 million in 1971 (4). 1/ This production was equal to 4.7 and 5.0 percent, respectively, of the nonfat dry milk manufactured for food during these years. Including U.S. territorial shipments, dry whole milk exports during 1970 and 1971 amounted to 40.1 and 55.8 percent of the dry whole milk production.

From a technological standpoint, the production procedure and process for making dry whole milk is not too different from that used to make nonfat dry milk (1, p. 149). Technological packaging advances, in terms of materials and equipment, may prove to be significant in providing the domestic market with a whole milk powder that would find domestic market acceptance as a beverage. Currently, tests are being conducted with flexible packaging materials. These tests may provide a foil pouch that can be used for packaging dry whole milk.

This report deals with the cost of processing, agglomerating (instantizing), and packaging dry whole milk for consumer use as a beverage.

Processing and fixed investment costs are based upon a combination of information from earlier published reports and the economic-engineering method of analysis. These costs should not be viewed as representative of a specific plant or company's operation. They are, however, to be considered as attainable costs under normal operating conditions. Thus, all cost estimates presented are optimal costs and are obtained on the basis of a model plant operating under specified conditions.

1/ Underscored numbers in parentheses refer to items in Literature Cited at the end of this report.

DEVELOPMENT OF COST ESTIMATES

Assumptions

This analysis is based upon the following assumptions:

1. Existing milk-drying facilities and equipment will be used to make dry whole milk.

2. Current processing technology will provide for making a dry whole milk which will reconstitute into an acceptable beverage.

3. Milk-drying cost data available in published reports are representative for the milk-drying industry.

4. A gas-flushed laminated foil pouch will provide the type of packaging required to maintain the product quality and shelf life.

5. The drying plant packages nonfat dry milk only in 20-quart (reconstituted), 4-pound consumer packages on a two-shift-per-day basis.

6. Purchase of new form-fill-seal packaging equipment along with the required peripheral equipment to build a new packaging line in the powder plant will be required.

7. Adequate space is available in the existing plant structure without making structural changes or constructing a new addition to install the new packaging line.

8. The nonfat dry milk packaging line will be shut down when the dry whole milk line is operating. Thus, no additional personnel will be required for the new packaging line.

9. The plant processes 500,000 pounds of fluid milk containing 3.70 percent butterfat and 8.62 percent solids-not-fat each operating day. This is equal to 60,700 pounds of dry whole milk.

Methodology

Information and data contained in various publications and reports were used as a basis for developing current cost estimates. Also, information obtained through discussions with equipment manufacturers and visits to milk powder processing plants was used to update earlier information as well as to provide basic information relating to flexible-pouch packaging costs for dry whole milk.

Basic cost data reported by Kerchner (2, pp. 22-23) were updated to estimated 1972 rates by applying the percentage change for selected consumer price and wholesale price indexes for 1965-72 to the original data (table 1).

Table 1--Items and indexes used to estimate 1972 values

Item	Index used to inflate value	1965 annual average (dollars or: index no.)	1972 annual average (dollars or: index no.)	Percent change 1965-72
Labor	BLS-dairy industry hourly earnings index (SIC-202)	$2.49/hr.	$3.65/hr.	+46.59
Insurance	BLS-consumer price index (property insurance index)	89.8	123.2	+37.19
Taxes	BLS-consumer price index (property tax index)	91.5	145.7	+59.24
Repairs and maintenance	BLS-consumer price index (maintenance index)	91.3	140.7	+54.11
Fuel	BLS-wholesale price index (gas fuels index)	92.8	114.1	+22.95
Electricity	BLS-wholesale price index (electric power index)	100.1	121.5	+21.38
Water and sewer	BLS-consumer price index (water & sewer service index)	94.4	138.5	+46.72
Packaging supplies	BLS-wholesale price index (converted paper & paper-board products index)	94.7	113.6	+19.96
General supplies	BLS-wholesale price index (machinery & equipment index)	93.9	117.9	+25.56

Depreciation and interest charges used for 1972 were unchanged from 1965. This action was based upon the assumption that these changes would remain a constant annual charge over the estimated life of the structure and processing equipment.

PROCESSING COSTS

Nonfat Dry Milk Costs

Table 2 shows a comparison of the 1965 and 1972 costs estimated by major processing and administrative centers for a powder plant.

The cost of processing 1,000 pounds of fluid milk into powder in 1965 was $1.87, compared with $2.41 per 1,000 pounds of fluid milk in 1972. During the 7-year period, processing costs increased by 54 cents per 1,000 pounds, or 29 percent.

Table 2--Costs estimated by production centers for processing 1,000 pounds of whole milk, 1965 and 1972

Cost center	Estimated 1965 cost	Estimated 1972 cost
	Dollars	
Raw milk receiving	0.06	0.08
Evaporating and drying	1.00	1.26
Powder packaging and warehousing	.45	.57
Administration:		
Laboratory	.08	.10
Office	.28	.40
Total	1.87	2.41

Based upon market milk containing 3.7 percent butterfat and 8.62 percent solids-not-fat, the processing cost per pound of nonfat dry milk increased from 2.17 cents per pound in 1965 to 2.80 cents in 1972--a 29-percent increase. 2/ These figures include packaging costs for bulk packaging in 50-pound kraft paper bags. Based solely upon evaporating and drying cost, the 1965 figure would be 1.16 cents per pound, and the 1972 figure, 1.46 cents per pound--a 25.9-percent increase.

Dry Whole Milk Costs

The manufacturing process for dry whole milk is similar to that used to make nonfat dry milk (1, p. 149). Also, either the single-pass or double-pass instantizing process (3, p. 1) should be used in order to improve dispersion of the powder in water. Two important differences exist between processing nonfat dry milk and whole milk. First, the skim milk is condensed to 40 to 48 percent total solids content when making nonfat dry milk. To make dry whole milk by using the foam-spray drying process, the milk is standardized so that the dry product will have not less than 26-percent butterfat and 50-percent total solids content during the evaporation process (1, p. 151). Second, in the whole-milk drying procedure, nitrogen gas is pumped into the concentrated milk at the rate of 0.5 standard cubic feet of gas per gallon of 50 percent total solids milk concentrate (1, p. 151).

Recent developments indicate that compressed air can perform the same function as nitrogen gas when making whole milk powder. For the purpose of this report, it will be assumed that compressed air will be used in making whole milk powder. The use of compressed air instead of nitrogen represents an estimated savings in manufacturing costs of 0.193 cent per pound of whole milk powder. This savings is based upon a nitrogen gas cost of 1.522 cents

2/ Cost per pound = \$1.87 ÷ 86.20 lbs. solids-not-fat/1,000 lbs. fluid milk.

per cubic foot of gas--a total daily cost of gas amounting to $117.25 for daily production of 60,700 pounds of dry whole milk.

In view of the similarity in making nonfat dry milk and dry whole milk, it is presumed that the 1972 costs shown in table 2 for processing nonfat dry milk less the cost of packaging would be the cost for processing dry whole milk. Thus, the 1972 cost for processing dry whole milk is estimated to be $2.41 per 1,000 pounds of fluid milk processed.

Agglomerating (Instantizing) Costs

The estimated cost of instantizing milk powder by using the double-pass procedure is 4.33 cents per pound (table 3). This figure represents the direct and indirect costs associated with the double-pass process except for (1) basic powder cost, (2) premium paid for instant-grade powder, and (3) packaging costs. These three cost components were eliminated from this total since there would be a double counting of these values when computing the savings from using the single-pass drying process in place of the double-pass agglomerating procedure.

Table 3--Estimated cost of instantizing double-pass process

Factor	Cost
	Cents/lb.
Freight (drying plant to instantizing plant)	1.00
Powder (receiving, handling, and warehousing)	.65
Instantizing	.92
Processing powder loss	.50
Process license fee	.25
Administrative	1.01
Total instantizing cost	4.33

Source: (3, p. 14).

The double-pass procedure costs would not be applicable if the foam-spray drying process were used to make the powder. In this process, the drying and agglomerating procedures are combined into a single operation, and the finished product emerging from the process does not require any further processing. Therefore, on a cost basis, a product made by the single-pass method would be 4.33 cents per pound less than a product made by using the double-pass procedure.

PACKAGING COSTS

Equipment Costs

Currently, dry whole milk is not packaged for consumer use in flexible packages. Nonfat dry milk, however, is available for household use in this type of packaging. The main reason that dry whole milk is not packaged in this material is that oxygen in the package reacts with fat globules in the milk powder to give the reconstituted product a rancid taste.

Recent developments in packaging materials have provided a laminated foil material which includes an oxygen scavenger as an integral part of the package pouch. This new development may allow dry whole milk to be packaged in a flexible package.

It is assumed that a new packaging line would be required by any existing powder-processing facility interested in processing dry whole milk powder using this new flexible package of laminated foil.

The packaging material being used in packaging tests with whole milk powder is not currently used commercially. Also, a standard retail size or type of package for dry whole milk powder has not been developed either for commercial or governmental use. Therefore, packaging costs for materials, equipment, and operation of the packaging line are synthesized costs.

Table 4 presents a list of equipment that would be required for the addition of a flexible packaging line to an existing plant, including estimated cost of installation and freight charges. These figures should be viewed as minimal values since any specifically engineered line for a certain location could require more of a specific type of equipment as well as more sophisticated types of equipment at a significantly different cost.

Table 4--Packaging equipment required to establish a flexible packaging line in a whole milk powder plant, 1972

Item	Number or quantity required	Estimated equipment cost including installation	Estimated freight cost	Total cost installed
		Dollars		
Vertical twin-tube, pouch-forming, filling, and weighing machine (66 pouches per min. fill rate)	2	29,500	150	59,300
Carton former and sealer	1	25,000	20	25,020
Shipping case sealer	1	28,000	60	28,060
Conveyor line	75 ft.	4,875	25	4,900
Total		87,375	255	117,280

Based upon a 10-year, straight-line depreciation schedule and an estimated salvage value of $10,000, annual depreciation charges would amount to $8,828. 3/ Assuming an annual packaging rate of 15,782,000 pounds of dry whole milk, depreciation expenses per pound of powder would amount to 0.06 cent.

Labor Costs

The type and number of personnel required to operate the model packaging line were based upon information obtained from observing powder-packaging operations in a number of plants. Table 5 shows the number of people required for one shift to operate the line, the estimated 1972 hourly wage rate (including fringe benefits), and the total hourly labor cost.

Table 5--Personnel classifications, estimated hourly wage rates including fringe benefits, and estimated total hourly labor cost for a model flexible packaging line, 1972

Personnel classification	Estimated 1972 gross hourly wage rate	Number required for one shift	Total hourly cost
	Dollars	Number	Dollars
Working foreman	3.81	1	3.81
Packaging-line operator	3.45	5	17.25
Cleanup man	3.45	1	3.45
Total packaging-line personnel			24.51

The estimated hourly wage rates for 1972 were developed by adding 20 cents per hour to 1971 estimated wage rates for the three types of personnel (3, p. 3). The 20-cent figure was the difference between the Bureau of Labor Statistics average hourly earnings figure of $3.65 per hour in 1972 and $3.45 per hour in 1971. Based upon packaging 7,920 of the 8-ounce pouches per hour with two machines, the labor cost per pound of powder packaged is 0.62 cent ($24.51 ÷ 3,960 pounds).

Material Costs

The laminated film used in making pouches for the packaging tests consisted of the following layers: (1) plastic film, (2) aluminum foil, (3) plastic film, (4) scavenger material, and (5) plastic film.

3/ Annual depreciation = $\frac{\$98,280.00-10,000.00}{10}$ = $8,828.00.

Technical development and testing of the flexible pouch material designed for use with dry whole milk indicate that this material is ready for use in commerical packaging systems. For purposes of this report, however, it will be necessary to use dimensions and material quantities not only for the flexible pouches but also for the cartons and shipping cases which may or may not be identical to the units developed and designed for commercial market use. Table 6 shows the type, dimensions, and estimated costs of the packaging materials used in this analysis.

Table 6--Estimated types and quantity of packaging materials used for packaging dry whole milk in flexible packages, 1972

Item and material	Dimensions (width, length, and height)	Cost each	Cost per pound of powder
	Inches	Cents	
Pouch:			
Laminated plastic and aluminum foil (8 oz. net product weight)	2(4½" x 10")	4.00	8.00
Folding carton:			
26-pt. bleach sulphite board, seal end, 2-color print. (3 lbs. net product weight)	4½" x 6¼" x 8¼"	4.77	1.59
Shipping case:			
Corrugated kraft board regular slotted-type container (36 lbs. net product weight)	14" x 25¼" x 8½"	30.00	0.83
Total packaging material cost			10.42

Total material cost per pound of powder amounts to 10.42 cents per pound (table 6). This figure is significantly more than the packaging material cost for nonfat dry milk of 3.38 cents per pound of powder (3, p. 14).

Industrial Gas Costs

An important part of the pouch-packaging system designed for use with dry whole milk is the gas mixture used in forming, filling, and sealing the pouches. It contains 92 percent nitrogen and 8 percent hydrogen. This mixture has two functions: first, to flush air out of the pouch and replace it with the gas mixture prior to adding the powder and second, to remove the residual oxygen after the pouch has been sealed.

Based upon 0.0315 cubic foot of gas mixture used for packaging 8-ounces of milk powder in the laminated foil pouch, it is estimated that 230 cubic feet of nitrogen gas and 20 cubic feet of hydrogen gas per hour would be required to package foil pouches at a rate of 132 per minute for 2 machines.

Since the volume of hydrogen is relatively small in terms of commercial volume usage, it is presumed that the hydrogen gas would be obtained from commercial cylinders or tanks. The cost of the gas in these cylinders, which contain 210 cubic feet of gas, is about $8 per cylinder, or 3.810 cents per cubic foot of gas.

The nitrogen required in this packaging system can most likely be best supplied in one of two ways. These are by using an inert-gas generator or by using a liquid nitrogen supply system. Significant cost differences can exist between the methods used to supply nitrogen for the pouch-filling operation.

Cost of a completely installed unit for generating inert gas would amount to about $13,525. This figure includes equipment and installation charges for a 500-cubic-foot-per-hour gas generating unit plus a compressor, all necessary controls, and two 473-cubic-foot storage tanks.

Based upon a 10-year equipment life span and a $2,000 salvage value, annual depreciation expense is estimated to be $1,152.50. This expense amounts to 0.133 cent per cubic foot of nitrogen gas produced when using 869,400 cubic feet annually for packaging purposes. Hourly costs for the utilities required to operate the generating unit (natural gas, electricity, and water) are estimated at 7.02 cents per operating hour, or 0.014 cent per cubic foot of nitrogen (7.02 cents ÷ 500 cu. ft.). The total cost per cubic foot of nitrogen gas, when produced by this inert-gas generating system, would amount to 0.147 cent per cubic foot (0.133 cent plus 0.014 cent).

The cost of supplying nitrogen for the packaging operation by using liquid nitrogen is significantly greater. However, depending upon an individual company's situation, it might be the system selected if factors other than cost are the prime decision factors. A liquid nitrogen system would require capital expenditures for a proportioner (mixer), regulating valve, and hose amounting to an estimated $580. Using a 10-year equipment life span and no salvage value, annual depreciation cost would amount to $58. This cost would be equal to 0.007 cent per cubic foot of nitrogen when using 869,400 cubic feet of nitrogen annually. Tanks of liquid nitrogen which supply 3,630 cubic feet of nitrogen gas cost about $55 each, or 1.515 cents per cubic foot of nitrogen gas. Total nitrogen cost using this liquid nitrogen supply system would be 1.522 cents per cubic foot of gas used.

A comparison of the cost differences that would exist between an inert-gas generating operation and a liquid nitrogen system is as follows:

Type of gas and quantity required for 8-ounce pouch of dry whole milk	Inert-gas generator system		Liquid nitrogen supply system	
	Cost per cu. ft.	Total cost	Cost per cu. ft.	Total cost
	Cents			
Nitrogen: .029 cubic feet	0.147	0.004	1.515	0.044
Hydrogen: .003 cubic feet	3.810	.011	3.810	.011
Total gas cost per 8-ounce pouch		.015		.055
Total gas cost per pound whole milk powder		.030		.110

Total Flexible Packaging Costs

The total packaging cost per pound of whole milk powder using a flexible package including a carton and shipping container is estimated as follows:

Item	Cost per pound whole milk powder
	Cents
Depreciation expense	0.06
Labor	0.62
Packaging materials (pouch, folding carton, shipping case)	10.42
Gas for packaging	0.11
Overhead	0.33
Total	11.54

The preceding figure for total packaging cost is based upon the use of a liquid nitrogen gas supply system. If an inert-gas generating system were used to supply the nitrogen, the total cost would be 11.46 cents per pound of dry whole milk.

The overhead expense was assumed to be the same as for instantizing nonfat dry milk (3, p. 14). While that expense was for an instantizing operation, it was assumed, for purposes of this report, it would be the same for this type of operation. This assumption is based upon the hypothesis that the differences between the packaging lines would not be significant in terms of plant layout and operational requirements.

ESTIMATED COST OF DRY WHOLE MILK

As indicated earlier in this report, the method by which fluid milk is converted into powder can make a significant difference in its final cost. The cost of fluid milk, whether using the single-pass or double-pass instantizing

process would be the same at the start. Table 7 presents the cost of dry whole milk for both processes. Raw milk cost used in these computations was $5.01 per hundredweight (1972 average annual price received by farmers for manufacturing-grade milk). The yield of dry whole milk from 100 pounds of milk is 12.14 pounds.

Table 7--Estimated dry whole milk processing and packaging costs, by single-pass and double-pass instantizing process

Item	Single-pass instantizing process	Double-pass instantizing process
	Cents/lb. of dry product	
Raw material:		
Fluid milk	41.27	41.27
Processing and packaging:		
Raw milk receiving	.08	.08
Evaporating and drying	1.26	1.26
Warehousing	.19	.19
Instantizing	1/	4.33
Packaging, including flush gas	11.54	11.54
Administration	.41	.41
Total cost 2/	54.75	59.08

1/ Cost included in evaporating and drying figure.
2/ Based on using liquid nitrogen gas supply system. If the inert-gas generating system is used, these figures would be 0.08 cent lower.

The preceding totals include the costs for all operations prior to placing the milk powder into the warehouse. They do not include any allowance for return on investment, Federal, State, or local income taxes, or taxes other than real property taxes.

Effective March 15, 1973, the support price for manufacturing-grade milk was set at $5.29 per 100 pounds of fluid milk. This price would increase the fluid milk cost shown in table 7 to 43.58 cents per pound. 4/ Also, the total cost of powder made by a single-pass process would increase from 54.75 cents per pound to 57.06 cents, and the 59.08 cents for the double-pass process would increase to 61.39 cents.

4/ $5.29 per cwt. ÷ 12.14 lbs. of whole milk powder = 43.58 cents per lb. of powder.

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